中美洲人的身體組成

Body composition in MesoAmerica

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The fundamental paradigm for the region is short stature. Adult height is on the order of 160 cm for men and 140 cm for women. The timing of this delayed growth has been fixed to the first two years of life, when as much as 2 Z-scores of stature may be loss to the median of the NCHS reference. In the elderly of the region, we have the issue of being initially short and then suffering further loss of stature with age. The height/armspan ratio has proven instructive for exploring that change in height with age. It appears to be less than in Europeans.

Demands of a rigorous agricultural lifestyle, the energy content and density of the diet, and the ravages of recurrent infection and parasitism comprise the environmental determinants of body composition in poor MesoAmerican population. They are conducive to a low storage of fat, with lean body mass being subject to response to infections. Because of the basic short stature but muscular maturity of children and adults, one questions whether the assumptions of proportionality of weight for height from the NCHS reference data apply, or whether MesoAmericans should be normally greater in weight for height than a comparably short North American. For some at the lower end of the stature scale, no international reference standards actually exist for adults.

All than can be measured with microtoise, calliper, flexible tape and balance has long been recorded in MesoAmerican populations. Certain high-cost and facility- dependent technologies, such as nuclear magnetic resonance imaging and whole-body neutron activation analysis, are beyond the scientific economies of any part of the region. Dual energy x-ray absorbitometry instruments are available for clinical diagnosis in Mexico, Guatemala and Costa Rica, and could be turned to research ends. Underwater weighing has been practiced variously in MesoAmerica. Researchers in Guatemala have pioneered in the investigative use of bioelectrical impedance analysis to all ages from low-weight newborns to the very elderly; currently, introduction of the multifrequency BIA to Guatemalan laboratories, and application to the very young in dehydrated (diarrhoea) and overhydrated (kwashiorkor) states are being conducted.

The geography and culture of MesoAmerica

Physical geographers have divided the world into seven continents: Antarctica; Oceania; Europe; Africa; Asia; North America; and South America. The Darian Gap in the south of Panama is taken as the physical demarcation boundary separating South America. The regions of the Western Hemisphere, including islands in the Caribbean and mainland areas on both continents, in which the romance languages of Spanish and Portuguese are spoken, is known as 'Latin America.' Through political evolution from the era of the Spanish colonial reign to the independence of sovereign republics, the five nations of Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica — once administered from Spain as a single entity — have become known as 'Central America.' An English-speaking appendage to this area, Belize (formerly British Honduras), is classified by default as Central American as well. However, if we look at the pre-Columbian cultures of the American continents, we have a heritage of cultural divisions of the advanced American indigenous civilizations in which the Inca and Aymara dominated an Andean culture; the Maya and the Aztecs, with an extension from the centre of Mexico to the Darian Gap, constituted 'MesoAmerican' groups. Through the years of the encounter with European culture and conquest in the region, the enduring characterizing feature of human society in this latter region has been the underlying indigenous heritage, in an interaction with Spanish populations. For the purpose of this discussion, then, the territorial extensions and populations of Mexico and Central America define MesoAmerica and the MesoAmericans.

The terrain, the economic pursuits and the traditional diet of the MesoAmerica exercise important interactions with ethnicity in determining nutritional status and body composition. Much of the extent is mountainous and volcanic, and, in the geological sphere, seismically very active. The region includes mountains and highlands, fertile coastal plains, arid interior deserts, and one of the most important remaining rainforests in the hemisphere.

The lake bed of Tenochitlan was the centre of the Aztec domain. It is now the site of Mexico City, the largest metropolitan area of the world. The economy of this metropolis includes formal service and manufacturing industries as well as a huge informal economy. Mexico City is the largest megacity in the world, with a metropolitan population estimated in excess of 17 million. South of Mexico City, rural populations and agricultural pursuits predominate. The subsistence crops include maize, beans and wheat. Natural hydrocarbons (petroleum, natural gas) provide the largest sources of foreign exchange for the Mexican population together with coffee, sugar cane, bananas and cotton. Cattle are important for

domestic production and export. Crops for industrial processing include various classes of cacti and derivative products.

The agricultural situation described above is not vastly different for the entire extension of the Central American Isthmus that stretches southward from Mexico between the Caribbean and the Pacific. The heritage of the great civilizations of MesoAmerica along with the natural recreational areas of rivers, lakes and beaches, moreover, set the basis for an important regional and international tourism industry.

The traditional diet of MesoAmerica is based on *maize*. It is prepared as *tamales*, or as the flat corn pancake, the *tortilla*. This is consumed with boiled legumes (common beans). In the far southern region of MesoAmerica, rice and beans replace corn and beans as the prime sources of both protein and calories. Very little protein of animal origin is consumed. The low consumption of meat, milk and eggs, and sparse consumption of vegetables is propitious to the development of deficiencies of both fat- and water-soluble vitamins. Nutritional anaemia due to iron deficiency is widespread. MesoAmerica is also a zone of endemic goiter.

Concepts and assessment of human body composition

Wang et al.[1] have defined five distinct levels of consideration for body composition: atomic, molecular, cellular, tissue-system, and whole body. The different levels require different measuring instruments and techniques. Under the guise of 'nutritional status assessment,' anthropometric measurements of length/height, weight, circumferences and skinfold thicknesses have been made over the years. Anthropometry is the least expensive, least invasive and easiest to perform of all of the techniques for assessing body composition. In its nutritional application, it has been used in classification of individuals into various classes of inadequate nutriture, normal nutriture or over nutrition[2,3] or as a screening tool for functional consequences of nutritional risk[4]. Nutritional classification schemes are textured and differentiated depending upon the age-group in question.

Issues of stature and linear growth

Short childhood stature

Viteri and Torun[5] have reviewed the prevalences of stunting as derived from the Central American survey of 1965–7, applying the Gomez classification. The percentage of children with some diagnostic grade of weight-for-age deficit in the various nations is shown in Table 1. Similar data have been obtained from a recent national survey in Mexico[6], in which 31.1% of children has some degree of deficit in weight.

However, the low weight in the children in the great majority is explained by a low stature. The most transcendental reality of anthropometry, and the point of departure for considering body composition in MesoAmerica is short stature.

Height 'deficit' is assessed in relation to expected linear attainment in relation to a reference pattern, adjusted for age. Currently, the National Centre for Health Statistics (NCHS) height curve for the US population is the reference. Height-for-age is determined by taking, as a reference the median height for the subject's same age on the reference curve, and dividing the subject's own height by that value times 100, to express as a percentage. By convention, extreme short stature (<2 SD of the median height of international standards) has been defined as 'stunting.'[7]

Timing of the determination of short stature

If short stature were indeed tantamount to chronic malnutrition, one would expect the loss of height to be a continuous and progressive process throughout the formative years. What has been recognized recently is the early onset of the height deficit. It does not have a life-long development, but occurs within the first two or three years of life. Recent data from a peri-urban population of children 6–72 months in Guatemala City, illustrate the dynamic of height loss[8,9]. The children at one year had a cumulative height deficit of almost −2-score; similar data, showing early linear growth retardation come from the Solis Valley in Mexico[10]. At 6 months, the children had a −1.3 height Z-score, falling further to a −1.9 Z-score, at 30 months.

Adult short adult stature

Adults from Mexico to Costa Rica are short. The average height for a Dutch man is 180 cm. In MesoAmerica, men will have an adult height some 15–20 cm lower. Thus, the most important issue with respect to short stature is its nutritional interpretation. All grades of short stature have been attributed to the mechanism of 'chronic malnutrition.' Spurr et al.[11,12] have defined chronically malnourished populations of adults on the basis of short stature. One of the economic consequences of this short stature, documented in these studies, is that the individual worker is less productive.

Short and shortening elderly stature

If early childhood height deficits lead to childhood and adult short stature, the shortening that occurs from age 30 years onward[13] associated with the aging process adds an additional component to the cumulative deficit. One can appreciate this additional age-related shortening using the height-to-

Table 1. Children below 5 years of age in Central America, 1965–7, presenting growth retardation which, by the Gómex Classification, could be catalogued as malnourished*.

Country	Total population below 5 years of age	1st, 2nd and 3rd degree malnourished No. of cases	%	malnourished 1st degree No. of cases	%	2nd degree No. of cases	%	3rd Degree No. of cases	%
Costa Rica	294 300	153 200	52.0	117 900	40.0	31 300	10.6	4000	1.4
El Salvador	554 400	380 000	68.5	244 600	44.1	116 900	21.1	18 500	3.3
Guatemala	833 400	611 660	73.4	380 100	45.6	197 700	23.7	33 860	4.1
Honduras	346 900	221 300	63.7	143 000	41.2	71 200	20.5	7100	2.0
Nicaragua	287 500	148 800	51.8	112 300	39.1	32 400	11.3	4100	1.4
Panama	207 900	104 947	50.4	84 625	40.7	18 990	9.1	1332	0.6
Total	2 524 400	1 619 907	64.2	1 082 525	42.9	468 490	18.6	68 892	2.7

*Numbers are extrapolations from a statistically representative sample.

armspan ratio[13]. The combined processes of narrowing of the intervertebral disk spaces and compression of the vertebral bodies themselves causes a variable reduction in standing height. Since the distance for finger-tip to finger-tip with the arms extended maximally is largely composed of long-bones, this measurement does not change with time. Early in adult life, the height/armspan ratio for a **group** (population) is 1.0, with aging, it declines progressively. Extensive studies in Guatemala have employed the height-to-armspan ratio, with the collective conclusion that height-loss with age is less than in white Europeans.

Issues of appropriateness of weight related to stature

Weight-for-height (childhood issues)
Weight-for-height is calculated using the NCHS standard as the database, by determining the relationship of the weight of a given subject to the weight of the 50th percentile of a population with the subject's height. That is, the subject's weight is divided by the reference (50th percentile) weight for an NCHS child of identical height and multiplied by 100.

We might question whether a zero-deviation (Z-score of 0.0) is an appropriate and ideal weight-for-height measurement for short stature in toddlers and preschoolers, especially given the relevance of absolute body composition and age. The reference child with a comparable height of a stunted child is much younger in age (up to two years). One asks whether the somatic proportions for an older child are appropriately to those of a younger child of a similar stature. Do age and development **independently** determine the mass of lean and fat mass? The children of the 'La Peronia' neighbourhood in Guatemala City had Z-scores for weight-for-height which were close to −2.0 in both genders. The research of Boutton et al.[14] and Trowbridge et al.[15] is illustrative of the previous question, as Peruvian preschool children were measured anthropometrically, and had an average of +0.5 Z-score in weight-for-height; they are heavier for their stature than the Central American peers[8,9]. Using deuterium dilution, it was found that these children's 'excess' weight was in the form of *lean* mass, rather than fat. For the given length, short Peruvian children had more viscera and muscle weight than Guatemalans. If age is an independent factor, then, it is logical that in Peru the conditions may be more appropriate for the body composition development of short children, and that the 'perfectly proportioned' short children of Guatemala may, in fact, have a deficit of lean-body mass. Curiously, the Mexican children in the Solis Valley[10] had, at 30 months, a weight-for-height Z-score of +0.4, similar to the Peruvians, although the composition of the excess weight is not known.

Weight-for-height (adult/elderly issues)
The primary problem in the use of weight-for-height in MesoAmerican adults is the difficulties of calculating the index for a large majority of the population. As noted by Geissler and Miller[16]:

> Two sets of 'weight for height' reference data that are widely used internationally for children and adolescents (NCHS) and for adults (Fogarty) show a marked discontinuity such that young adults might be considered obese by one set and underweight by the other.

They proceeded to perform a computerized, mathematical 'smoothing' of the curve in the area of discontinuity of the juvenile and adult references. The resulting curve was meant to be universal and 'unisex.' Siu-Lui[19] (1987) attempted the weight-for-height classification of 163 elderly men and women. She found that 50% of women and 80% of men had heights that placed them into the smoothed part of the Geissler and Miller curve[16].

Quetelet's body mass index (BMI) has been assessed in persons over 60 years of age in three groups of elderly — one metropolitan, one suburban and one agrarian rural — within a 45 km radius of Guatemala City, as reviewed by Herman.[17] By contrast, in Costa Rica, there were virtually no elderly subjects at the low end of the BMI distribution, but many of the females in the overweight or obese classification[19].

Application of newer techniques of body composition assessment
At least in Guatemala, in Central America, some of the newer techniques of body composition, beyond physical anthropometric measurements have been utilized. These include hydrodensitometry[20], monofrequency bioelectrical impedance[8,9,17,21], and multi-frequency bioelectrical impedance (McCormick & Mazariegos, unpublished findings).

Conclusion
The international convergence of interest in body composition comes at a propitious moment for nations of the Third World in general, and for the region of Central America in particular. We have a constituency of scientists with training and experience in the field. We will soon see the potential for introduction of newer analytical technology. Paradigms relating to short stature and to rapid changes in hydration state dominate the questions in Central America.

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